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Abstract

STUDIES OF NEUTRON THERMALIZATION BY A MODIFIED PULSED SOURCE TECHNIQUE

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The conventional pulsed-source technique has been extensively used as a source of information on the thermalization processes of neutrons in moderating assemblies. This information is derived from the "diffusion cooling" coefficient obtained in pulsed source experiments. There are large discrepancies between the results given by different authors [1], while some of the theoretical limitations of the use of "diffusion cooling" measurements as a source of thermalization data were formulated in 1958 [2].

A new method for measuring neutron thermalization parameters that has been proposed on theoretical grounds [3] was tested experimentally in the present work. The theory is extended and results are presented in closed forms. The experiment was performed on H_2O, as the method in its present form is most suitable for the study of homogeneous systems in which strong "non $\frac{1}{v}$" absorbers can be dispersed.

The experimental set-up is described, and details are given of the geometrical arrangement used to suppress some of the higher "harmonic modes". Details of two special methods for the analysis of experimental results are given. These methods

enable the use of data taken at quite short delays after the burst of fast neutrons.

The neutron thermalization parameters in the present formulation are:

$$\gamma_{ij} = \int_0^\infty \int_0^\infty \frac{E}{T^2} e^{-E/T} \Sigma_s(E \rightarrow E') \left[L_i^{(1)}\left(\frac{E}{T}\right) - L_i^{(1)}\left(\frac{E'}{T}\right) \right] L_j^{(1)}\left(\frac{E}{T}\right) dE dE'$$

where T is the temperature of the system in energy units, E is the energy of a neutron, $\Sigma_s(E \rightarrow E')$ is the macroscopic cross section for scattering of a neutron of energy E into a unit energy interval at E', and $L_i^{(1)}\left(\frac{E}{T}\right)$ are the associated Laguerre polynomials of order unity and degree i. The results for H_2O at 23°C can be described by $\gamma_{11} = (0.210 \pm 0.026)$ cm^{-1}. This result differs significantly from results obtained by "diffusion cooling" measurements, and from calculated values based on Nelkin's model for H_2O [4]. These discrepancies are discussed, as well as the feasibility of the method for the study of different systems.

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